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PATENT
Attorney Reference Number 6047-51973

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Terry L. Gilton and Li Li

Application No. 09/321,518

Filed: May 27, 1999

Confirmation No. 6563

For: SEMICONDUCTOR FABRICATION APPARATUS

Examiner: Wai Sing Louie

Art Unit: 2814

Attorney Reference No. 6047-51973

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Respectfully submitted,

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APPELLANT'S APPEAL BRIEF

This brief is in furtherance of the Notice of Appeal dated July 25, 2003, and received July 29, 2003. The fee required under 37 C.F.R. § 1.17(c) is enclosed.

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TABLE OF CONTENTS

I. Real Party in Interest

The real party in interest is Micron Technology, Inc., by an assignment from the inventors recorded with the U.S. Patent and Trademark Office at Reel 010017, Frames 0173-0176. Micron Technology, Inc. is a Delaware corporation having a place of business at 8000 S. Federal Way, Boise, Idaho 83706-9632.

II. Related Appeals and Interferences

There are no other appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. Status of Claims

Claims 1-38 were previously cancelled and claims 39-56 are pending in the instant application. Claims 39-56 are on appeal.

IV. Status of Amendments

All amendments have been entered. Applicants have not filed any amendments subsequent to the final rejection of the application.

V. Summary of Invention

The invention, as set forth in the claims, concerns an apparatus for cleaning or otherwise removing material, such as photoresist, from an in-process semiconductor wafer. FIG. 2 of the present application, for example, shows an embodiment of an apparatus that includes a chamber 10 that is sized to receive at least one wafer 12 to be cleaned of photoresist or various other

materials or residues. See page 7, lines 20-21 of the application. This embodiment of the apparatus also includes a solvent source 34 and a reactant-gas source 38, both of which are in communication with the chamber 10. See page 8, lines 1-5.

The solvent source 34 (which can be, for example, a boiler) introduces a liquid solvent (e.g., water) into the chamber 10 such that the liquid solvent forms a liquid layer or film on at least one surface of the wafer 12. The liquid solvent is inert to the wafer surface. That is, the liquid solvent does not react with the surface of the wafer or any material on the wafer surface. See page 8, lines 19-25. The reactant-gas source 38 introduces into the chamber 10 a reactant gas (e.g., ozone) that is capable of reacting directly with the material that is to be removed from the wafer surface. See page 8, lines 10-13. The liquid solvent layer on the wafer surface serves as a transport medium for the reactant gas by placing the reactant gas in direct physical contact with the wafer surface. The reactant gas is then at a suitable concentration on the wafer surface so as to relatively quickly and effectively react with material on the wafer surface to effect removal of such material. See page 8, lines 19-25.

VI. Issues

A. Whether the Patent Office met its burden of establishing that claims 39-41, 43-48, and 50-56 are anticipated by U.S. Patent No. 5,762,755 to McNeilly et al., (McNeilly).

B. Whether the Patent Office met its burden of establishing that claims 42 and 49 are obvious in view of McNeilly, U.S. Patent No. 4,795,497 to McConnell et al., (McConnell), and U.S. Patent No. 4,946,549 to Bachman et al., (Bachman).

VII. Grouping of Claims

A. Rejection of Claims 39-41, 43-48, and 50-56

Claims 39-41, 43-48, and 50-56 stand rejected as allegedly being anticipated by McNeilly. Independent claims 39, 44, 46, 50, 51, 55, and 56 are independently patentable over McNeilly, and their respective dependent claims each contain limitations that further distinguish the claims over McNeilly. However, to facilitate the Board's consideration of this appeal, Applicants group claims 39-41, 43-48, and 50-56 for purposes of this appeal as follows:

The patentability of claims 41, 44, 46, 48, 50, 51, and 52 stands or falls with the patentability of claim 39.

The patentability of claim 45 stands or falls with the patentability of claim 40.

The patentability of claim 43 stands or falls on its own.

The patentability of claim 47 stands or falls on its own.

The patentability of claim 53 stands or falls on its own.

The patentability of claim 54 stands or falls on its own.

The patentability of claim 55 stands or falls on its own.

The patentability of claim 56 stands or falls on its own.

B. Rejection of Claims 42 and 49

Claims 42 and 49 stand rejected as allegedly being obvious in view of McNeilly, McConnell, and Bachman.

For at least the reasons discussed below, claims 42 and 49 are each independently patentable over McNeilly, McConnell, and Bachman. Thus, claims 42 and 49 each stand or fall on their own.

VIII. Arguments

A. The Cited Prior Art

1. U.S. Patent No. 5,762,755 to McNeilly et al.

McNeilly appears to disclose an apparatus 1 that is operable to pre-clean semiconductor wafers of contaminants prior to etching, and to subsequently etch the wafers using conventional vapor phase etching techniques. See McNeilly, col. 3, lines 53-62. As shown in FIG. 1 of McNeilly, apparatus 1 comprises a chamber 2 for receiving a wafer 3 and an ozone generator 25 connected to the chamber 2 via an inlet 13. The ozone generator 25 is used to introduce ozone into the chamber 2 for pre-cleaning the wafer 3 prior to etching. McNeilly, col. 10, lines 54-56. A radiation source 11 (FIG. 1), such as a UV and/or IR light source, heats the wafer 3 during the cleaning step. McNeilly, col. 10, lines 37-45. During the pre-cleaning step, the wafer is heated to about 250°C. McNeilly, col. 12, line 15.

Following the pre-cleaning step, the wafer is etched using conventional etching techniques (either a vapor phase HF/H_2O solution to etch oxide or Cl_2 for etching silicon). See McNeilly, col. 2, lines 29-32; col. 3, lines 35-39; and FIG. 1. If vapor phase HF/H_2O oxide etching is used, vaporizers 21 and 22 (FIG. 1) (which may comprise the flash evaporator 59 of FIG. 4) deliver HF/H_2O to the chamber 2 via inlet 13. McNeilly, col. 10, lines 59-60. The HF/H_2O vapor solution condenses on the wafer surface. McNeilly, col. 3, lines 64-66. The condensed layer of HF/H_2O solution etches the wafer surface. McNeilly, col. 3, line 63 through col. 4, line 10.

2. U.S. Patent No. 4,795,497 to McConnell et al.

McConnell allegedly discloses a system for treating semiconductor wafers with a plurality of fluids. McConnell, col. 5, lines 20-22 and FIG. 1. In the McConnell system, the wafers are positioned in a vertical position so that "filming effects" (forming layers or films) are avoided. McConnell, col. 3, lines 13-22.

3. U.S. Patent No. 4,946,549 to Bachman et al.

Bachman allegedly discloses a method of fabricating or modifying a body (such as a printed circuit board) having a polymer layer. The method includes removing a portion of the polymer layer by a plasma etching process. See Bachman, col. 3, lines 42-47. Bachman states that it is known to add N_2O, CF_4, or SF_6 gas to an oxygen gas flow in a plasma etcher to increase the etch rate of polyimide and photoresists from silicon wafers. See Bachman, col. 2, lines 59-67.

B. 35 U.S.C. § 102(e) Rejection of Claims 39-41, 43-48, and 50-56

Claims 39-41, 43-48, and 50-56 stand rejected under 35 U.S.C. § 102(e) as allegedly being anticipated by McNeilly. For at least the following reasons, Applicants disagree that these claims are anticipated by McNeilly.

1. Independent Claim 39

Claim 39 is directed to a wafer cleaning apparatus comprising a chamber sized to receive at least one wafer to be cleaned. A solvent applicator is coupled to the chamber and is adapted to vaporize and apply a solvent to a surface of the wafer so as to form a film of liquid solvent on the wafer surface, wherein the liquid solvent is inert to the wafer surface. A temperature controller

is operable to maintain the wafer at a temperature equal to or lower than about a dew point of the solvent. A gas source of at least one reactive gas is coupled to the chamber so as to deliver such gas to the chamber. The liquid solvent comprises a transport medium which carries at least some of the reactive gas through the film to the wafer surface, thereby causing the reactive gas to chemically react with wafer surface.

McNeilly neither teaches nor suggests at least the following features of claim 39: (1) a solvent applicator adapted to apply a liquid film of solvent on a wafer surface, wherein the liquid solvent is inert to the wafer and (2) the liquid solvent comprising "a transport medium which carries" a reactive gas through the film to the wafer surface.

Solvent Applicator

In the rejection of claim 39, the Examiner contends that, at col. 4, lines 20-22, McNeilly discloses "a solvent applicator 59" that vaporizes and applies a film of water on a wafer surface. See Office action dated February 25, 2003 (action), page 2. This contention is incorrect.

McNeilly, at col. 3, line 59 through col. 4, line 22,[1] describes a classic vapor phase etching procedure, by which a gaseous solution of HF/H_2O is condensed on a wafer surface. The HF/H_2O solution etches away (by chemical reaction) material on the wafer surface. The McNeilly apparatus includes a flash evaporator 59 that vaporizes the HF/H_2O solution, which is then conducted into chamber 2 for etching wafer 3. McNeilly, col. 11, lines 19-22. McNeilly states that "anhydrous HF will not generally etch thermal oxide without the addition of H_2O." McNeilly, col. 4, lines 20-22. This means that HF must be applied to the wafer as an aqueous solution (HF/H_2O), not water by itself. At no point does McNeilly teach or suggest an applicator adapted to apply a liquid film of an inert solvent. In other words, unlike the applicator for

[1] This portion includes the passage cited by the Examiner.

applying the liquid solvent in Applicants' invention (which is inert to materials on the wafer surface), the McNeilly evaporator forms a gaseous HF/H_2O solution that acts as an etching agent to chemically react with material on the wafer surface. Hence, McNeilly's flash evaporator 59 is not the same as or equivalent to the solvent applicator that applies a liquid solvent that is inert to a wafer surface, as recited in claim 39.

Inert Solvent Transport Medium

The Examiner states that McNeilly discloses a "liquid solvent [that] comprises transport medium 29," which carries a reactive gas to the wafer surface. See action, page 3. Applicants agree that McNeilly discloses a transport medium 29. However, transport medium 29 in the McNeilly apparatus is not a liquid solvent, but is actually a source of argon or nitrogen gas. The argon or nitrogen gas serves as a transport medium for carrying the vaporized HF/H_2O solution into the chamber 2 of the McNeilly apparatus. See McNeilly, col. 10, lines 57-60 and FIG. 1.

The argon or nitrogen gas transport mediums as taught by McNeilly are not liquid transport mediums and do not form a "film of liquid solvent." The atmosphere in the McNeilly apparatus would have to be at least less than about -190°C for these gases to ever form a liquid. Clearly, McNeilly does not teach or suggest a cryogenic atmosphere sufficient to cause these gases to form a liquid.

Further, the Examiner's analysis of McNeilly's teachings with respect to claim 39 is logically inconsistent. On one hand, the Examiner states that McNeilly's "liquid solvent" that forms a liquid film that is inert to the wafer surface is water introduced into chamber 2 by solvent applicator 59 (although it is actually a vaporized HF/H_2O solution). On the other hand, the Examiner states that McNeilly's transport medium is the argon or nitrogen gas from source 29. Thus, the Examiner is asserting that McNeilly's "inert" liquid film and its transport medium

(argon or nitrogen gas) are two distinct substances. However, in claim 39, the inert liquid film is the transport medium. That is, the inert liquid film must also form the transport medium. McNeilly does not teach or suggest the limitations of claim 39. Furthermore, McNeilly's liquid film is aqueous HF, which is not inert to the wafer surface.

Accordingly, the rejection of claim 39 should be reversed.

Claims 41, 44, 46, 48, 50, 51, and 52 recite respective combinations of features that likewise differentiate them from McNeilly. Hence, for at least reasons similar to those presented for claim 39, McNeilly fails to teach or suggest the apparatuses of claims 41, 44, 46, 48, 50, 51, and 52, and the rejection of these claims should be reversed.

2. Dependent Claim 40

Claim 40 depends from claim 39 and is patentable for the reasons set forth above in support of claim 39 and because claim 40 further recites that the gas incorporator is "adapted to introduce said at least one reactant gas into the solvent prior to forming the film of liquid solvent."

In the rejection of claims 39 and 40, the Examiner states that McNeilly discloses "a gas source 25 of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber." See action, page 3. However, there is no teaching or suggestion in McNeilly that gas source 25 introduces gas into a solvent from a solvent applicator 59, as recited in claim 40. The rejection of claim 40 therefore should be reversed.

3. Dependent Claim 43

Dependent claim 43 depends from independent claim 42 but is rejected as anticipated by McNeilly. Claim 42 stands rejected under 35 U.S.C. § 103(a) as allegedly being obvious from McNeilly, McConnell, and Bachman. If claim 42 is not anticipated by McNeilly, then claim 43 certainly cannot be anticipated by McNeilly. The rejection of claim 43 should be reversed.

4. Dependent Claim 47

Claim 47 depends from claim 39 and is patentable for the reasons given above in support of claim 39 and because claim 47 further recites that "the concentration of dissolved gas in the solvent is between about 10% and about 95% by volume." McNeilly does not even disclose a reactant gas that is dissolved in a liquid solvent, let alone specify a desired concentration of a dissolved gas in a liquid solvent.

In the rejection of claim 47, the Examiner contends that at col. 8, line 29, McNeilly discloses a dissolved gas concentration of "6.17%". However, this passage of McNeilly is of no relevance to the issue at hand. The portion of McNeilly cited by the Examiner actually states that 6.17% is the "average one-stigma uniformity value." The average one-stigma uniformity value is understood to represent etching uniformity of a wafer. Such a value is completely unrelated to the concentration of a gas in a solvent. The rejection of claim 47 should be reversed.

5. Dependent Claim 53

Claim 53 depends from claim 51 and is patentable for the reasons given above in support of claim 51 and further because claim 53 recites that "the film of condensed liquid solvent has a thickness between about 1 micrometer and about 3000 micrometers."

In the rejection of claim 53 the Examiner states that "McNeilly et al. disclose the film of condensed liquid solvent has a thickness about 1μm and about 3000 μm (see table 4 and 5)." See action, page 4. This statement is incorrect. Tables 4 and 5 of McNeilly actually provide data relating to etching uniformity, etching time, pre-etching treatment time, and etch contamination. The values listed in tables 4 and 5 are completely unrelated to the apparatus recited in claim 53. The rejection of claim 53 should be reversed.

6. Independent Claim 55

Claim 55 recites an apparatus for cleaning semi-conductor wafers. The apparatus of claim 55 includes a chamber sized to receive at least one wafer and a solvent applicator coupled to the chamber and adapted to drip solvent onto at least one side surface of the wafer so as to form a film of liquid solvent on the wafer surface. The solvent is substantially non-chemically reactive with the wafer surfaces. A gas source of at least one reactive gas is coupled to the chamber to deliver the gas to the chamber. The reactive gas is selected to chemically react with the wafer surface. In addition, the liquid solvent comprises a transport medium which dissolves at least some of the reactive gas in the film and brings the gas into direct contact with and chemically reacts with the wafer surface.

McNeilly neither teaches nor suggests at least the following features of claim 55: (1) a solvent applicator coupled to the chamber and adapted to drip solvent onto at least one side surface of the wafer; (2) a liquid solvent film that is substantially non-chemically reactive with the wafer surface; and (3) the liquid solvent comprising a transport medium, which dissolves at least some of the reactive gas in the film and brings the gas into direct contact with and chemically reacts with the wafer surface.

Solvent Applicator

Nowhere in McNeilly is there support for a solvent applicator that is adapted to *drip* solvent onto a wafer. In the rejection of claim 56, the Examiner apparently contends that McNeilly's flash evaporator 59 satisfies the "solvent applicator" claim limitation in claim 55. See action, page 2. However, as noted by the Examiner (see action, page 2), McNeilly's flash evaporator 59 *vaporizes* an etching solution, which is then conducted through an inlet 13 in the bottom of chamber 2. See McNeilly, FIGS. 2 and 3. Since the claimed solvent applicator is configured to *drip* solvent onto a wafer surface, McNeilly's flash evaporator 59 cannot satisfy this claim limitation.

Further, as shown in FIG. 1 of McNeilly, a vaporized HF/H_2O solution is introduced into chamber 2 through an inlet 13 that extends upwardly through the bottom of the chamber underneath the wafer 3. Since the inlet is positioned below the wafer, a liquid could not be dripped onto a surface of the wafer.

Liquid Solvent Film

McNeilly's solvent applicator 59 is a source of a chemically-reactive etching solution (HF/H_2O solution or Cl_2). Even if the etching solution formed a film on the surface of a wafer, such film would not be *substantially non-chemically reactive* with the wafer surface, as recited in claim 55.

Transport Medium

Lastly, McNeilly's gas source 29 (which the Examiner claims to satisfy the "transport medium" claim limitation) is not a liquid solvent, and therefore is not the same as a "liquid solvent comprising a transport medium" as recited in claimed 55.

Accordingly, for at least the foregoing reasons, McNeilly does not anticipate or render obvious claim 55, and the rejection of claim 55 should be reversed.

7. Independent Claim 56

Claim 56 recites a wafer-cleaning apparatus comprising a chamber, a nebulizer adapted to create a mist of a solvent, and a temperature control device operable to cool the wafer such that the mist of solvent condenses and forms a film of the liquid solvent on the surface of a wafer, wherein the solvent is substantially non-chemically reactive with the wafer surface. A gas source of at least one reactive gas is coupled to the chamber so as to deliver such gas to the chamber. The reactive gas is selected to chemically react with the wafer surface. In addition, the liquid solvent comprises a transport medium that dissolves at least some of the reactive gas in the film and brings the gas into direct contact with and chemically reacts with the wafer surface.

McNeilly neither teaches nor suggests at least the following features of claim 56: (1) a nebulizer adapted to create a mist of a solvent; (2) a liquid solvent film that is substantially non-chemically reactive with the wafer surface; and (3) the liquid solvent comprising a transport medium, which dissolves at least some of the reactive gas in the film and brings the gas into direct contact with and chemically reacts with the wafer surface.

<u>Nebulizer</u>

A nebulizer is a device that generates a mist of airborne droplets in liquid form. See page 10, lines 12-16 of the present application. McNeilly fails to provide any disclosure for such a device.

In the rejection of claim 56 the Examiner apparently contends that McNeilly's flash evaporator 59 meets the "nebulizer" claim limitation of claim 56. However, McNeilly's flash

evaporator 59 vaporizes an etching solution; it does not create a mist of liquid droplets. Hence, McNeilly's solvent applicator 59 is not even arguably equivalent to a "nebulizer".

Liquid Solvent Film and Transport Medium

McNeilly does not teach or suggest a liquid equivalent to the liquid solvent film of the claimed apparatus because McNeilly's liquid solvent is an etching solution that chemically reacts with material on a wafer. Also, McNeilly does not teach or suggest the transport medium of the claimed apparatus because McNeilly's "transport medium" 29 is a gas (either argon or nitrogen), not a liquid solvent, as recited in claim 56.

Since McNeilly does not satisfy at least the foregoing claim elements, claim 56 is not anticipated or rendered obvious by McNeilly, and the rejection of claim 56 should be reversed.

C. 35 U.S.C. § 103(a) Rejection of Claims 42 and 49

Claims 42 and 49 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over McNeilly in view of McConnell and Bachman.

1. Independent Claim 42

Claim 42 is directed to an apparatus for delivering ozone gas to the surface of a wafer. The apparatus of claim 42 comprises a chamber, a wafer carrier positioned in the chamber, and a wafer positioned in the wafer carrier in a substantially vertical position. A liquid depositor is adapted to produce a stream of liquid solvent in a direction substantially parallel to a surface of the wafer and form a layer of the liquid solvent on the wafer surface. The liquid solvent layer transports ozone gas from a gas source to the wafer surface.

Neither McNeilly, McConnell, nor Bachman (either alone or in combination) teaches or suggests at least the following features of claim 42: (1) a liquid depositor adapted to produce a

stream of liquid solvent and form a layer of the liquid solvent on at least one major surface of a wafer, wherein the stream is produced in a direction substantially parallel to the wafer surface; (2) the layer of liquid solvent being inert to the wafer surface; and (3) the liquid solvent layer transporting ozone gas to the wafer surface.

In the rejection of claim 42, the Examiner states that McNeilly teaches the limitations recited of claim 39 except for a wafer carrier for supporting a wafer in a vertical position. The Examiner cites McConnell as teaching such a wafer carrier. The Examiner does not contend that Bachman teaches or suggests any features recited in claim 42.

Liquid Depositor

McNeilly's apparatus does not include any component that produces a stream of liquid solvent. McNeilly's flash evaporator 59 generates a vaporous HF/H_2O solution, and therefore does not satisfy this claim element.

Further, the liquid depositor of the claimed apparatus produces a stream of liquid in a direction parallel to the wafer surface. Even if the McNeilly apparatus had such a liquid depositor (which it does not), McNeilly provides no disclosure for producing a stream of liquid (or gas) in a direction parallel to the wafer surface.

Liquid Solvent Layer

McNeilly fails to provide any disclosure that teaches a liquid solvent layer that is inert to a wafer surface or a liquid solvent layer that serves to transport ozone to the wafer surface, as recited in claim 42.

Accordingly, for at least the foregoing reasons, claim 42 is not anticipated or rendered obvious by McNeilly, McConnell, or Bachman (either alone or in combination), and the rejection of claim 42 should be reversed.

2. Dependent Claim 49

Claim 49 depends from claim 39 and is patentable for the reasons given above in support of claim 49 and because claim 49 further recites that the liquid solvent is a perfluorocarbon.

In the rejection of claim 49, the Examiner concedes that McNeilly does not disclose a perfluorocarbon solvent, but contends that Bachman teaches using a perfluorocarbon solvent, such as CF_4 and other poly-fluorocarbon material, for removing photoresist from wafers. See action, page 5. Applicants agree that Bachman teaches using CF_4 to remove material from a workpiece. However, the teachings of Bachman are irrelevant to the claimed apparatus.

For example, Bachman actually teaches mixing CF_4 *gas* with oxygen during plasma etching to increase etching rates. See Bachman, col. 2, lines 59-67 and col. 6, lines 12-18. The CF_4/O_2 gas mixture is not a liquid solvent and does not form a layer of liquid on the surface of the workpiece being etched. Consequently, Bachman does not make up for the deficiencies of McNeilly. The rejection of claim 49 should be reversed.

IX. Conclusion

The Final Rejection failed to establish anticipation of claims 39-41, 43-48, and 50-56 or obviousness of claims 42 and 49. Accordingly, the rejection of these claims should be reversed and all claims passed to issue.

Respectfully submitted,

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APPENDIX

CLAIMS ON APPEAL

39. An apparatus for cleaning semi-conductor wafers, the wafers having first and second wafer side surfaces, the apparatus comprising:

a chamber sized to receive at least one wafer to be cleaned;

a solvent applicator coupled to the chamber and adapted to vaporize and apply a solvent to at least one of the first and second side surfaces of the wafer positioned within the chamber so as to form a film of liquid solvent on said at least one of the first and second wafer side surfaces, the liquid solvent being inert to said at least one of the first and second wafer side surfaces;

a temperature controller positioned and operable to maintain the at least one wafer at a temperature equal to or lower than about a dew point of the solvent;

a gas source of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber, the at least one reactive gas being selected to chemically react with the surface of the wafer to clean the wafer; and wherein

the liquid solvent comprises a transport medium which carries at least some of the at least one reactive gas through the film to said at least one of the first and second wafer side surfaces where the at least one reactive gas chemically reacts with said at least one of the first and second wafer side surfaces.

40. An apparatus according to claim 39 including a gas incorporator adapted to introduce said at least one reactant gas into the solvent prior to forming the film of liquid solvent.

41. An apparatus according to claim 39 wherein said at least one reactant gas comprises ozone as a major component and the solvent comprises water as a major component.

42. An apparatus for delivering ozone gas to the surface of a wafer comprising:

a wafer receiving chamber;

a wafer carrier positioned within the chamber;

at least one wafer positioned in the wafer carrier in a substantially vertical position within the wafer receiving chamber;

a liquid depositor adapted to produce a stream of liquid solvent and form a layer of the liquid solvent on at least one major surface of a wafer supported by the wafer carrier within the chamber, wherein the stream is produced in a direction substantially parallel to the at least one major surface of the wafer, the layer of liquid solvent being inert to said at least one major surface of the wafer;

an ozone gas source coupled to the chamber so as to deliver ozone gas to the chamber and increase the concentration of ozone gas within the chamber;

the liquid solvent layer transporting ozone gas to the surface of the wafer to thereby expose the wafer surface to ozone.

43. An apparatus according to claim 42 wherein the apparatus includes a temperature controller adapted to maintain the temperature of the wafer at the dew point of the liquid such that liquid from the liquid depositor is condensed onto the wafer to form the layer of liquid.

44. An apparatus for cleaning semi-conductor wafers comprising:

a chamber sized to receive at least one wafer to be cleaned;

a reactant gas source inlet and outlet, the inlet and outlet each communicating with the chamber and defining a gas flow path for reactant gas from the inlet to the outlet;

a reactant gas source coupled to the inlet such that reactant gas is delivered from the inlet and flows in the gas flow path to the outlet;

a wafer carrier positioned within the chamber and supporting at least one wafer at least partially in the gas flow path;

a liquid layer former coupled to the chamber and operable to form a layer of liquid on at least one major surface of a wafer supported within the chamber, the liquid being selected so as to be substantially non-chemically-reactive with the reactant gas and the wafer, whereby the reactant gas is transported through the liquid layer to the wafer surface, the reactant gas being selected so as to chemically react with components on the surface of the wafer to clean the wafer; and

a temperature controller configured and operable to cool the at least one wafer in the chamber such that the liquid layer on the at least one major surface of the wafer is formed by condensation.

45. An apparatus according to claim 44 including a reactant gas incorporator adapted to introduce reactant gas into the liquid before the liquid layer is formed.

46. An apparatus for stripping photo-resist from semi-conductor wafers comprising:

a film former adapted to condense a solvent to form a film of liquid solvent onto a surface of the wafer which is to be stripped of photo-resist, the film of liquid solvent being substantially non-chemically reactive with the photo-resist;

a gas exposer adapted to expose the film of liquid solvent to a source of at least one reactant gas which is substantially non-chemically reactive with the solvent and which is chemically reactive with the photo-resist so as to the strip the photo-resist from the wafer surface;

a cooling mechanism operable to cool the surface of the wafer; and

whereby reactant gas is transported through the film of liquid solvent to the wafer surface.

47. An apparatus according to claim 39, wherein the concentration of dissolved gas in the solvent is between about 10% and about 95% by volume.

48. An apparatus according to claim 39, wherein the apparatus includes a temperature controller adapted to cool and maintain the wafer at or below ambient temperature.

49. An apparatus according to claim 39, wherein the solvent is a perfluorocarbon.

50. An apparatus for cleaning semi-conductor wafers, the wafers having first and second wafer side surfaces, the apparatus comprising:

a chamber sized to receive at least one wafer to be cleaned;

a solvent applicator coupled to the chamber and adapted to provide a vaporized solvent to at least one of the first and second side surfaces of the wafer positioned within the chamber so as to condense the vaporized solvent on the at least one of the first and second wafer side surfaces to form a thin layer of solvent thereon, the solvent being selected to be substantially non-chemically reactive with the wafer;

a gas source of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber, the at least one reactive gas being selected to chemically react with the surface of the wafer to clean the wafer; and wherein

the solvent layer dissolves at least some of the at least one reactive gas in the film such that dissolved gas is brought into direct contact with and chemically reacts with the at least one of the first and second wafer side surfaces.

51. An apparatus for cleaning semi-conductor wafers, the wafers having first and second wafer side surfaces, the apparatus comprising:

a chamber sized to receive at least one wafer to be cleaned;

a solvent applicator coupled to the chamber and adapted to vaporize a solvent and condense the solvent on at least one of the first and second side surfaces of the wafer positioned within the chamber so as to form a film of condensed liquid solvent on the at least one of the first and second wafer side surfaces, the solvent being substantially inert to the wafer;

a gas source of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber, the at least one reactive gas being selected to chemically react with the surface of the wafer to clean the wafer; and wherein

the condensed liquid solvent comprises a transport medium which dissolves at least some of the at least one reactive gas in the film to the at least one of the first and second wafer side surfaces where the at least one reactive gas chemically reacts with the at least one of the first and second wafer side surfaces.

52. An apparatus according to claim 51, further including a temperature controller to maintain the temperature of the wafer at the dew point of the vaporized solvent.

53. An apparatus according to claim 51, wherein the film of condensed liquid solvent has a thickness between about 1 micrometer and about 3000 micrometers.

54. An apparatus according to claim 51, wherein the concentration of dissolved gas in the solvent is between about 10% and 95% by volume.

55. An apparatus for cleaning semi-conductor wafers, the wafers having first and second wafer side surfaces, the apparatus comprising:

a chamber sized to receive at least one wafer to be cleaned;

a solvent applicator coupled to the chamber and adapted to drip solvent onto at least one of the first and second wafer side surfaces so as to form a film of liquid solvent on the at least one of the first and second wafer side surfaces, the solvent being substantially non-chemically reactive with the first or second wafer side surfaces;

a temperature control device adapted to cool the at least one wafer;

a gas source of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber, the at least one reactive gas being selected to chemically react with the surface of the wafer to clean the wafer; and wherein

the liquid solvent comprises a transport medium which dissolves at least some of the at least one reactive gas in the film where the dissolved gas is brought into direct contact with and chemically reacts with the at least one of the first and second wafer side surfaces.

56. An apparatus for cleaning semi-conductor wafers, the wafers having first and second wafer side surfaces, the apparatus comprising:

a chamber sized to receive at least one wafer to be cleaned;

a nebulizer adapted to create a mist of a solvent;

a temperature control device operable to cool the wafer such that the mist of solvent condenses on at least one of the first and second wafer side surfaces so as to form a film of liquid solvent on the at least one of the first and second wafer side surfaces, the solvent being substantially non-chemically reactive with a side surface of the wafer;

a gas source of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber, the at least one reactive gas being selected to chemically react with the surface of the wafer to clean the wafer; and wherein

the liquid solvent comprises a transport medium that dissolves at least some of the at least one reactive gas in the film where the dissolved gas is brought into direct contact with and chemically reacts with the at least one of the first and second wafer side surfaces.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Terry L. Gilton and Li Li
Application No. 09/321,518
Filed: May 27, 1999
Confirmation No. 6563
For: SEMICONDUCTOR FABRICATION APPARATUS
Examiner: Wai Sing Louie
Art Unit: 2814
Attorney Reference No. 6047-51973

CERTIFICATE OF MAILING

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APPELLANT'S APPEAL BRIEF

This brief is in furtherance of the Notice of Appeal dated July 25, 2003, and received July 29, 2003. The fee required under 37 C.F.R. § 1.17(c) is enclosed.

TABLE OF CONTENTS

I. Real Party in Interest

The real party in interest is Micron Technology, Inc., by an assignment from the inventors recorded with the U.S. Patent and Trademark Office at Reel 010017, Frames 0173-0176. Micron Technology, Inc. is a Delaware corporation having a place of business at 8000 S. Federal Way, Boise, Idaho 83706-9632.

II. Related Appeals and Interferences

There are no other appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. Status of Claims

Claims 1-38 were previously cancelled and claims 39-56 are pending in the instant application. Claims 39-56 are on appeal.

IV. Status of Amendments

All amendments have been entered. Applicants have not filed any amendments subsequent to the final rejection of the application.

V. Summary of Invention

The invention, as set forth in the claims, concerns an apparatus for cleaning or otherwise removing material, such as photoresist, from an in-process semiconductor wafer. FIG. 2 of the present application, for example, shows an embodiment of an apparatus that includes a chamber 10 that is sized to receive at least one wafer 12 to be cleaned of photoresist or various other

materials or residues. See page 7, lines 20-21 of the application. This embodiment of the apparatus also includes a solvent source 34 and a reactant-gas source 38, both of which are in communication with the chamber 10. See page 8, lines 1-5.

The solvent source 34 (which can be, for example, a boiler) introduces a liquid solvent (e.g., water) into the chamber 10 such that the liquid solvent forms a liquid layer or film on at least one surface of the wafer 12. The liquid solvent is <u>inert</u> to the wafer surface. That is, the liquid solvent does <u>not</u> react with the surface of the wafer or any material on the wafer surface. See page 8, lines 19-25. The reactant-gas source 38 introduces into the chamber 10 a reactant gas (e.g., ozone) that is capable of reacting directly with the material that is to be removed from the wafer surface. See page 8, lines 10-13. The liquid solvent layer on the wafer surface serves as a transport medium for the reactant gas by placing the reactant gas in direct physical contact with the wafer surface. The reactant gas is then at a suitable concentration on the wafer surface so as to relatively quickly and effectively react with material on the wafer surface to effect removal of such material. See page 8, lines 19-25.

VI. Issues

A. Whether the Patent Office met its burden of establishing that claims 39-41, 43-48, and 50-56 are anticipated by U.S. Patent No. 5,762,755 to McNeilly et al., (McNeilly).

B. Whether the Patent Office met its burden of establishing that claims 42 and 49 are obvious in view of McNeilly, U.S. Patent No. 4,795,497 to McConnell et al., (McConnell), and U.S. Patent No. 4,946,549 to Bachman et al., (Bachman).

VII. Grouping of Claims

A. Rejection of Claims 39-41, 43-48, and 50-56

Claims 39-41, 43-48, and 50-56 stand rejected as allegedly being anticipated by McNeilly. Independent claims 39, 44, 46, 50, 51, 55, and 56 are independently patentable over McNeilly, and their respective dependent claims each contain limitations that further distinguish the claims over McNeilly. However, to facilitate the Board's consideration of this appeal, Applicants group claims 39-41, 43-48, and 50-56 for purposes of this appeal as follows:

The patentability of claims 41, 44, 46, 48, 50, 51, and 52 stands or falls with the patentability of claim 39.

The patentability of claim 45 stands or falls with the patentability of claim 40.

The patentability of claim 43 stands or falls on its own.

The patentability of claim 47 stands or falls on its own.

The patentability of claim 53 stands or falls on its own.

The patentability of claim 54 stands or falls on its own.

The patentability of claim 55 stands or falls on its own.

The patentability of claim 56 stands or falls on its own.

B. Rejection of Claims 42 and 49

Claims 42 and 49 stand rejected as allegedly being obvious in view of McNeilly, McConnell, and Bachman.

For at least the reasons discussed below, claims 42 and 49 are each independently patentable over McNeilly, McConnell, and Bachman. Thus, claims 42 and 49 each stand or fall on their own.

VIII. Arguments

A. The Cited Prior Art

1. U.S. Patent No. 5,762,755 to McNeilly et al.

McNeilly appears to disclose an apparatus 1 that is operable to pre-clean semiconductor wafers of contaminants prior to etching, and to subsequently etch the wafers using conventional vapor phase etching techniques. See McNeilly, col. 3, lines 53-62. As shown in FIG. 1 of McNeilly, apparatus 1 comprises a chamber 2 for receiving a wafer 3 and an ozone generator 25 connected to the chamber 2 via an inlet 13. The ozone generator 25 is used to introduce ozone into the chamber 2 for pre-cleaning the wafer 3 prior to etching. McNeilly, col. 10, lines 54-56. A radiation source 11 (FIG. 1), such as a UV and/or IR light source, heats the wafer 3 during the cleaning step. McNeilly, col. 10, lines 37-45. During the pre-cleaning step, the wafer is heated to about 250°C. McNeilly, col. 12, line 15.

Following the pre-cleaning step, the wafer is etched using conventional etching techniques (either a vapor phase HF/H_2O solution to etch oxide or Cl_2 for etching silicon). See McNeilly, col. 2, lines 29-32; col. 3, lines 35-39; and FIG. 1. If vapor phase HF/H_2O oxide etching is used, vaporizers 21 and 22 (FIG. 1) (which may comprise the flash evaporator 59 of FIG. 4) deliver HF/H_2O to the chamber 2 via inlet 13. McNeilly, col. 10, lines 59-60. The HF/H_2O vapor solution condenses on the wafer surface. McNeilly, col. 3, lines 64-66. The condensed layer of HF/H_2O solution etches the wafer surface. McNeilly, col. 3, line 63 through col. 4, line 10.

2. U.S. Patent No. 4,795,497 to McConnell et al.

McConnell allegedly discloses a system for treating semiconductor wafers with a plurality of fluids. McConnell, col. 5, lines 20-22 and FIG. 1. In the McConnell system, the wafers are positioned in a vertical position so that "filming effects" (forming layers or films) are avoided. McConnell, col. 3, lines 13-22.

3. U.S. Patent No. 4,946,549 to Bachman et al.

Bachman allegedly discloses a method of fabricating or modifying a body (such as a printed circuit board) having a polymer layer. The method includes removing a portion of the polymer layer by a plasma etching process. See Bachman, col. 3, lines 42-47. Bachman states that it is known to add N_2O, CF_4, or SF_6 gas to an oxygen gas flow in a plasma etcher to increase the etch rate of polyimide and photoresists from silicon wafers. See Bachman, col. 2, lines 59-67.

B. 35 U.S.C. § 102(e) Rejection of Claims 39-41, 43-48, and 50-56

Claims 39-41, 43-48, and 50-56 stand rejected under 35 U.S.C. § 102(e) as allegedly being anticipated by McNeilly. For at least the following reasons, Applicants disagree that these claims are anticipated by McNeilly.

1. Independent Claim 39

Claim 39 is directed to a wafer cleaning apparatus comprising a chamber sized to receive at least one wafer to be cleaned. A solvent applicator is coupled to the chamber and is adapted to vaporize and apply a solvent to a surface of the wafer so as to form a film of liquid solvent on the wafer surface, wherein the liquid solvent is inert to the wafer surface. A temperature controller

is operable to maintain the wafer at a temperature equal to or lower than about a dew point of the solvent. A gas source of at least one reactive gas is coupled to the chamber so as to deliver such gas to the chamber. The liquid solvent comprises a transport medium which carries at least some of the reactive gas through the film to the wafer surface, thereby causing the reactive gas to chemically react with wafer surface.

McNeilly neither teaches nor suggests at least the following features of claim 39: (1) a solvent applicator adapted to apply a liquid film of solvent on a wafer surface, wherein the liquid solvent is inert to the wafer and (2) the liquid solvent comprising "a transport medium which carries" a reactive gas through the film to the wafer surface.

<u>Solvent Applicator</u>

In the rejection of claim 39, the Examiner contends that, at col. 4, lines 20-22, McNeilly discloses "a solvent applicator 59" that vaporizes and applies a film of water on a wafer surface. See Office action dated February 25, 2003 (action), page 2. This contention is incorrect.

McNeilly, at col. 3, line 59 through col. 4, line 22,[1] describes a classic vapor phase etching procedure, by which a gaseous solution of HF/H_2O is condensed on a wafer surface. The HF/H_2O solution etches away (by chemical reaction) material on the wafer surface. The McNeilly apparatus includes a <u>flash</u> <u>evaporator</u> 59 that vaporizes the HF/H_2O solution, which is then conducted into chamber 2 for etching wafer 3. McNeilly, col. 11, lines 19-22. McNeilly states that "anhydrous HF will not generally etch thermal oxide without the addition of H_2O." McNeilly, col. 4, lines 20-22. This means that HF must be applied to the wafer as an aqueous solution (HF/H_2O), not water by itself. At no point does McNeilly teach or suggest an applicator adapted to apply a liquid film of an inert solvent. In other words, unlike the applicator for

[1] This portion includes the passage cited by the Examiner.

applying the liquid solvent in Applicants' invention (which is inert to materials on the wafer surface), the McNeilly evaporator forms a gaseous HF/H_2O solution that acts as an etching agent to chemically react with material on the wafer surface. Hence, McNeilly's flash evaporator 59 is not the same as or equivalent to the solvent applicator that applies a liquid solvent that is inert to a wafer surface, as recited in claim 39.

Inert Solvent Transport Medium

The Examiner states that McNeilly discloses a "liquid solvent [that] comprises transport medium 29," which carries a reactive gas to the wafer surface. See action, page 3. Applicants agree that McNeilly discloses a transport medium 29. However, transport medium 29 in the McNeilly apparatus is not a liquid solvent, but is actually a source of argon or nitrogen gas. The argon or nitrogen gas serves as a transport medium for carrying the vaporized HF/H_2O solution into the chamber 2 of the McNeilly apparatus. See McNeilly, col. 10, lines 57-60 and FIG. 1.

The argon or nitrogen gas transport mediums as taught by McNeilly are not liquid transport mediums and do not form a "film of liquid solvent." The atmosphere in the McNeilly apparatus would have to be at least less than about -190°C for these gases to ever form a liquid. Clearly, McNeilly does not teach or suggest a cryogenic atmosphere sufficient to cause these gases to form a liquid.

Further, the Examiner's analysis of McNeilly's teachings with respect to claim 39 is logically inconsistent. On one hand, the Examiner states that McNeilly's "liquid solvent" that forms a liquid film that is inert to the wafer surface is water introduced into chamber 2 by solvent applicator 59 (although it is actually a vaporized HF/H_2O solution). On the other hand, the Examiner states that McNeilly's transport medium is the argon or nitrogen gas from source 29. Thus, the Examiner is asserting that McNeilly's "inert" liquid film and its transport medium

(argon or nitrogen gas) are two distinct substances. However, in claim 39, the inert liquid film is the transport medium. That is, the inert liquid film must also form the transport medium. McNeilly does not teach or suggest the limitations of claim 39. Furthermore, McNeilly's liquid film is aqueous HF, which is not inert to the wafer surface.

Accordingly, the rejection of claim 39 should be reversed.

Claims 41, 44, 46, 48, 50, 51, and 52 recite respective combinations of features that likewise differentiate them from McNeilly. Hence, for at least reasons similar to those presented for claim 39, McNeilly fails to teach or suggest the apparatuses of claims 41, 44, 46, 48, 50, 51, and 52, and the rejection of these claims should be reversed.

2. Dependent Claim 40

Claim 40 depends from claim 39 and is patentable for the reasons set forth above in support of claim 39 and because claim 40 further recites that the gas incorporator is "adapted to introduce said at least one reactant gas into the solvent prior to forming the film of liquid solvent."

In the rejection of claims 39 and 40, the Examiner states that McNeilly discloses "a gas source 25 of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber." See action, page 3. However, there is no teaching or suggestion in McNeilly that gas source 25 introduces gas into a solvent from a solvent applicator 59, as recited in claim 40. The rejection of claim 40 therefore should be reversed.

3. Dependent Claim 43

Dependent claim 43 depends from independent claim 42 but is rejected as anticipated by McNeilly. Claim 42 stands rejected under 35 U.S.C. § 103(a) as allegedly being obvious from McNeilly, McConnell, and Bachman. If claim 42 is not anticipated by McNeilly, then claim 43 certainly cannot be anticipated by McNeilly. The rejection of claim 43 should be reversed.

4. Dependent Claim 47

Claim 47 depends from claim 39 and is patentable for the reasons given above in support of claim 39 and because claim 47 further recites that "the concentration of dissolved gas in the solvent is between about 10% and about 95% by volume." McNeilly does not even disclose a reactant gas that is dissolved in a liquid solvent, let alone specify a desired concentration of a dissolved gas in a liquid solvent.

In the rejection of claim 47, the Examiner contends that at col. 8, line 29, McNeilly discloses a dissolved gas concentration of "6.17%". However, this passage of McNeilly is of no relevance to the issue at hand. The portion of McNeilly cited by the Examiner actually states that 6.17% is the "average one-stigma uniformity value." The average one-stigma uniformity value is understood to represent etching uniformity of a wafer. Such a value is completely unrelated to the concentration of a gas in a solvent. The rejection of claim 47 should be reversed.

5. Dependent Claim 53

Claim 53 depends from claim 51 and is patentable for the reasons given above in support of claim 51 and further because claim 53 recites that "the film of condensed liquid solvent has a thickness between about 1 micrometer and about 3000 micrometers."

In the rejection of claim 53 the Examiner states that "McNeilly et al. disclose the film of condensed liquid solvent has a thickness about 1 μm and about 3000 μm (see table 4 and 5)." See action, page 4. This statement is incorrect. Tables 4 and 5 of McNeilly actually provide data relating to etching uniformity, etching time, pre-etching treatment time, and etch contamination. The values listed in tables 4 and 5 are completely unrelated to the apparatus recited in claim 53. The rejection of claim 53 should be reversed.

6. Independent Claim 55

Claim 55 recites an apparatus for cleaning semi-conductor wafers. The apparatus of claim 55 includes a chamber sized to receive at least one wafer and a solvent applicator coupled to the chamber and adapted to drip solvent onto at least one side surface of the wafer so as to form a film of liquid solvent on the wafer surface. The solvent is substantially non-chemically reactive with the wafer surfaces. A gas source of at least one reactive gas is coupled to the chamber to deliver the gas to the chamber. The reactive gas is selected to chemically react with the wafer surface. In addition, the liquid solvent comprises a transport medium which dissolves at least some of the reactive gas in the film and brings the gas into direct contact with and chemically reacts with the wafer surface.

McNeilly neither teaches nor suggests at least the following features of claim 55: (1) a solvent applicator coupled to the chamber and adapted to drip solvent onto at least one side surface of the wafer; (2) a liquid solvent film that is substantially non-chemically reactive with the wafer surface; and (3) the liquid solvent comprising a transport medium, which dissolves at least some of the reactive gas in the film and brings the gas into direct contact with and chemically reacts with the wafer surface.

Solvent Applicator

Nowhere in McNeilly is there support for a solvent applicator that is adapted to *drip* solvent onto a wafer. In the rejection of claim 56, the Examiner apparently contends that McNeilly's flash evaporator 59 satisfies the "solvent applicator" claim limitation in claim 55. See action, page 2. However, as noted by the Examiner (see action, page 2), McNeilly's flash evaporator 59 *vaporizes* an etching solution, which is then conducted through an inlet 13 in the bottom of chamber 2. See McNeilly, FIGS. 2 and 3. Since the claimed solvent applicator is configured to *drip* solvent onto a wafer surface, McNeilly's flash evaporator 59 cannot satisfy this claim limitation.

Further, as shown in FIG. 1 of McNeilly, a vaporized HF/H_2O solution is introduced into chamber 2 through an inlet 13 that extends upwardly through the bottom of the chamber underneath the wafer 3. Since the inlet is positioned below the wafer, a liquid could not be dripped onto a surface of the wafer.

Liquid Solvent Film

McNeilly's solvent applicator 59 is a source of a chemically-reactive etching solution (HF/H_2O solution or Cl_2). Even if the etching solution formed a film on the surface of a wafer, such film would not be *substantially non-chemically reactive* with the wafer surface, as recited in claim 55.

Transport Medium

Lastly, McNeilly's gas source 29 (which the Examiner claims to satisfy the "transport medium" claim limitation) is not a liquid solvent, and therefore is not the same as a "liquid solvent comprising a transport medium" as recited in claimed 55.

Accordingly, for at least the foregoing reasons, McNeilly does not anticipate or render obvious claim 55, and the rejection of claim 55 should be reversed.

7. Independent Claim 56

Claim 56 recites a wafer-cleaning apparatus comprising a chamber, a nebulizer adapted to create a mist of a solvent, and a temperature control device operable to cool the wafer such that the mist of solvent condenses and forms a film of the liquid solvent on the surface of a wafer, wherein the solvent is substantially non-chemically reactive with the wafer surface. A gas source of at least one reactive gas is coupled to the chamber so as to deliver such gas to the chamber. The reactive gas is selected to chemically react with the wafer surface. In addition, the liquid solvent comprises a transport medium that dissolves at least some of the reactive gas in the film and brings the gas into direct contact with and chemically reacts with the wafer surface.

McNeilly neither teaches nor suggests at least the following features of claim 56: (1) a nebulizer adapted to create a mist of a solvent; (2) a liquid solvent film that is substantially non-chemically reactive with the wafer surface; and (3) the liquid solvent comprising a transport medium, which dissolves at least some of the reactive gas in the film and brings the gas into direct contact with and chemically reacts with the wafer surface.

<u>Nebulizer</u>

A nebulizer is a device that generates a mist of airborne droplets in liquid form. See page 10, lines 12-16 of the present application. McNeilly fails to provide any disclosure for such a device.

In the rejection of claim 56 the Examiner apparently contends that McNeilly's flash evaporator 59 meets the "nebulizer" claim limitation of claim 56. However, McNeilly's flash

evaporator 59 vaporizes an etching solution; it does not create a mist of liquid droplets. Hence, McNeilly's solvent applicator 59 is not even arguably equivalent to a "nebulizer".

Liquid Solvent Film and Transport Medium

McNeilly does not teach or suggest a liquid equivalent to the liquid solvent film of the claimed apparatus because McNeilly's liquid solvent is an etching solution that chemically reacts with material on a wafer. Also, McNeilly does not teach or suggest the transport medium of the claimed apparatus because McNeilly's "transport medium" 29 is a gas (either argon or nitrogen), not a liquid solvent, as recited in claim 56.

Since McNeilly does not satisfy at least the foregoing claim elements, claim 56 is not anticipated or rendered obvious by McNeilly, and the rejection of claim 56 should be reversed.

C. 35 U.S.C. § 103(a) Rejection of Claims 42 and 49

Claims 42 and 49 stand rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over McNeilly in view of McConnell and Bachman.

1. Independent Claim 42

Claim 42 is directed to an apparatus for delivering ozone gas to the surface of a wafer. The apparatus of claim 42 comprises a chamber, a wafer carrier positioned in the chamber, and a wafer positioned in the wafer carrier in a substantially vertical position. A liquid depositor is adapted to produce a stream of liquid solvent in a direction substantially parallel to a surface of the wafer and form a layer of the liquid solvent on the wafer surface. The liquid solvent layer transports ozone gas from a gas source to the wafer surface.

Neither McNeilly, McConnell, nor Bachman (either alone or in combination) teaches or suggests at least the following features of claim 42: (1) a liquid depositor adapted to produce a

stream of liquid solvent and form a layer of the liquid solvent on at least one major surface of a wafer, wherein the stream is produced in a direction substantially parallel to the wafer surface; (2) the layer of liquid solvent being inert to the wafer surface; and (3) the liquid solvent layer transporting ozone gas to the wafer surface.

In the rejection of claim 42, the Examiner states that McNeilly teaches the limitations recited of claim 39 except for a wafer carrier for supporting a wafer in a vertical position. The Examiner cites McConnell as teaching such a wafer carrier. The Examiner does not contend that Bachman teaches or suggests any features recited in claim 42.

Liquid Depositor

McNeilly's apparatus does not include any component that produces a stream of liquid solvent. McNeilly's flash evaporator 59 generates a vaporous HF/H_2O solution, and therefore does not satisfy this claim element.

Further, the liquid depositor of the claimed apparatus produces a stream of liquid in a direction parallel to the wafer surface. Even if the McNeilly apparatus had such a liquid depositor (which it does not), McNeilly provides no disclosure for producing a stream of liquid (or gas) in a direction parallel to the wafer surface.

Liquid Solvent Layer

McNeilly fails to provide any disclosure that teaches a liquid solvent layer that is inert to a wafer surface or a liquid solvent layer that serves to transport ozone to the wafer surface, as recited in claim 42.

Accordingly, for at least the foregoing reasons, claim 42 is not anticipated or rendered obvious by McNeilly, McConnell, or Bachman (either alone or in combination), and the rejection of claim 42 should be reversed.

2. Dependent Claim 49

Claim 49 depends from claim 39 and is patentable for the reasons given above in support of claim 49 and because claim 49 further recites that the liquid solvent is a perfluorocarbon.

In the rejection of claim 49, the Examiner concedes that McNeilly does not disclose a perfluorocarbon solvent, but contends that Bachman teaches using a perfluorocarbon solvent, such as CF_4 and other poly-fluorocarbon material, for removing photoresist from wafers. See action, page 5. Applicants agree that Bachman teaches using CF_4 to remove material from a workpiece. However, the teachings of Bachman are irrelevant to the claimed apparatus.

For example, Bachman actually teaches mixing CF_4 *gas* with oxygen during plasma etching to increase etching rates. See Bachman, col. 2, lines 59-67 and col. 6, lines 12-18. The CF_4/O_2 gas mixture is not a liquid solvent and does not form a layer of liquid on the surface of the workpiece being etched. Consequently, Bachman does not make up for the deficiencies of McNeilly. The rejection of claim 49 should be reversed.

IX. Conclusion

The Final Rejection failed to establish anticipation of claims 39-41, 43-48, and 50-56 or obviousness of claims 42 and 49. Accordingly, the rejection of these claims should be reversed and all claims passed to issue.

Respectfully submitted,

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APPENDIX

CLAIMS ON APPEAL

39. An apparatus for cleaning semi-conductor wafers, the wafers having first and second wafer side surfaces, the apparatus comprising:

a chamber sized to receive at least one wafer to be cleaned;

a solvent applicator coupled to the chamber and adapted to vaporize and apply a solvent to at least one of the first and second side surfaces of the wafer positioned within the chamber so as to form a film of liquid solvent on said at least one of the first and second wafer side surfaces, the liquid solvent being inert to said at least one of the first and second wafer side surfaces;

a temperature controller positioned and operable to maintain the at least one wafer at a temperature equal to or lower than about a dew point of the solvent;

a gas source of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber, the at least one reactive gas being selected to chemically react with the surface of the wafer to clean the wafer; and wherein

the liquid solvent comprises a transport medium which carries at least some of the at least one reactive gas through the film to said at least one of the first and second wafer side surfaces where the at least one reactive gas chemically reacts with said at least one of the first and second wafer side surfaces.

40. An apparatus according to claim 39 including a gas incorporator adapted to introduce said at least one reactant gas into the solvent prior to forming the film of liquid solvent.

41. An apparatus according to claim 39 wherein said at least one reactant gas comprises ozone as a major component and the solvent comprises water as a major component.

42. An apparatus for delivering ozone gas to the surface of a wafer comprising:

a wafer receiving chamber;

a wafer carrier positioned within the chamber;

at least one wafer positioned in the wafer carrier in a substantially vertical position within the wafer receiving chamber;

a liquid depositor adapted to produce a stream of liquid solvent and form a layer of the liquid solvent on at least one major surface of a wafer supported by the wafer carrier within the chamber, wherein the stream is produced in a direction substantially parallel to the at least one major surface of the wafer, the layer of liquid solvent being inert to said at least one major surface of the wafer;

an ozone gas source coupled to the chamber so as to deliver ozone gas to the chamber and increase the concentration of ozone gas within the chamber;

the liquid solvent layer transporting ozone gas to the surface of the wafer to thereby expose the wafer surface to ozone.

43. An apparatus according to claim 42 wherein the apparatus includes a temperature controller adapted to maintain the temperature of the wafer at the dew point of the liquid such that liquid from the liquid depositor is condensed onto the wafer to form the layer of liquid.

44. An apparatus for cleaning semi-conductor wafers comprising:

a chamber sized to receive at least one wafer to be cleaned;

a reactant gas source inlet and outlet, the inlet and outlet each communicating with the chamber and defining a gas flow path for reactant gas from the inlet to the outlet;

a reactant gas source coupled to the inlet such that reactant gas is delivered from the inlet and flows in the gas flow path to the outlet;

a wafer carrier positioned within the chamber and supporting at least one wafer at least partially in the gas flow path;

a liquid layer former coupled to the chamber and operable to form a layer of liquid on at least one major surface of a wafer supported within the chamber, the liquid being selected so as to be substantially non-chemically-reactive with the reactant gas and the wafer, whereby the reactant gas is transported through the liquid layer to the wafer surface, the reactant gas being selected so as to chemically react with components on the surface of the wafer to clean the wafer; and

a temperature controller configured and operable to cool the at least one wafer in the chamber such that the liquid layer on the at least one major surface of the wafer is formed by condensation.

45. An apparatus according to claim 44 including a reactant gas incorporator adapted to introduce reactant gas into the liquid before the liquid layer is formed.

46. An apparatus for stripping photo-resist from semi-conductor wafers comprising:

a film former adapted to condense a solvent to form a film of liquid solvent onto a surface of the wafer which is to be stripped of photo-resist, the film of liquid solvent being substantially non-chemically reactive with the photo-resist;

a gas exposer adapted to expose the film of liquid solvent to a source of at least one reactant gas which is substantially non-chemically reactive with the solvent and which is chemically reactive with the photo-resist so as to the strip the photo-resist from the wafer surface;

a cooling mechanism operable to cool the surface of the wafer; and

whereby reactant gas is transported through the film of liquid solvent to the wafer surface.

47. An apparatus according to claim 39, wherein the concentration of dissolved gas in the solvent is between about 10% and about 95% by volume.

48. An apparatus according to claim 39, wherein the apparatus includes a temperature controller adapted to cool and maintain the wafer at or below ambient temperature.

49. An apparatus according to claim 39, wherein the solvent is a perfluorocarbon.

50. An apparatus for cleaning semi-conductor wafers, the wafers having first and second wafer side surfaces, the apparatus comprising:

a chamber sized to receive at least one wafer to be cleaned;

a solvent applicator coupled to the chamber and adapted to provide a vaporized solvent to at least one of the first and second side surfaces of the wafer positioned within the chamber so as to condense the vaporized solvent on the at least one of the first and second wafer side surfaces to form a thin layer of solvent thereon, the solvent being selected to be substantially non-chemically reactive with the wafer;

a gas source of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber, the at least one reactive gas being selected to chemically react with the surface of the wafer to clean the wafer; and wherein

the solvent layer dissolves at least some of the at least one reactive gas in the film such that dissolved gas is brought into direct contact with and chemically reacts with the at least one of the first and second wafer side surfaces.

51. An apparatus for cleaning semi-conductor wafers, the wafers having first and second wafer side surfaces, the apparatus comprising:

a chamber sized to receive at least one wafer to be cleaned;

a solvent applicator coupled to the chamber and adapted to vaporize a solvent and condense the solvent on at least one of the first and second side surfaces of the wafer positioned within the chamber so as to form a film of condensed liquid solvent on the at least one of the first and second wafer side surfaces, the solvent being substantially inert to the wafer;

a gas source of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber, the at least one reactive gas being selected to chemically react with the surface of the wafer to clean the wafer; and wherein

the condensed liquid solvent comprises a transport medium which dissolves at least some of the at least one reactive gas in the film to the at least one of the first and second wafer side surfaces where the at least one reactive gas chemically reacts with the at least one of the first and second wafer side surfaces.

52. An apparatus according to claim 51, further including a temperature controller to maintain the temperature of the wafer at the dew point of the vaporized solvent.

53. An apparatus according to claim 51, wherein the film of condensed liquid solvent has a thickness between about 1 micrometer and about 3000 micrometers.

54. An apparatus according to claim 51, wherein the concentration of dissolved gas in the solvent is between about 10% and 95% by volume.

55. An apparatus for cleaning semi-conductor wafers, the wafers having first and second wafer side surfaces, the apparatus comprising:

a chamber sized to receive at least one wafer to be cleaned;

a solvent applicator coupled to the chamber and adapted to drip solvent onto at least one of the first and second wafer side surfaces so as to form a film of liquid solvent on the at least one of the first and second wafer side surfaces, the solvent being substantially non-chemically reactive with the first or second wafer side surfaces;

a temperature control device adapted to cool the at least one wafer;

a gas source of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber, the at least one reactive gas being selected to chemically react with the surface of the wafer to clean the wafer; and wherein

the liquid solvent comprises a transport medium which dissolves at least some of the at least one reactive gas in the film where the dissolved gas is brought into direct contact with and chemically reacts with the at least one of the first and second wafer side surfaces.

56. An apparatus for cleaning semi-conductor wafers, the wafers having first and second wafer side surfaces, the apparatus comprising:

a chamber sized to receive at least one wafer to be cleaned;

a nebulizer adapted to create a mist of a solvent;

a temperature control device operable to cool the wafer such that the mist of solvent condenses on at least one of the first and second wafer side surfaces so as to form a film of liquid solvent on the at least one of the first and second wafer side surfaces, the solvent being substantially non-chemically reactive with a side surface of the wafer;

a gas source of at least one reactive gas coupled to the chamber so as to deliver such gas to the chamber, the at least one reactive gas being selected to chemically react with the surface of the wafer to clean the wafer; and wherein

the liquid solvent comprises a transport medium that dissolves at least some of the at least one reactive gas in the film where the dissolved gas is brought into direct contact with and chemically reacts with the at least one of the first and second wafer side surfaces.